REMARKS

Claims 20-62 are now pending in the application. Independent Claims 20, 39, and 54 are currently amended. Support for these amendments is found throughout the Applicants' specification as originally filed and at Page 6 line 30 bridging Page 7 line 4; Page 8 lines 2-3; Page 9 lines 14-17; Page 12 lines 15-21, 31-34; and Page 13 lines 1-5, for example. Claim 25 is amended to add a period at the end of the claim. The Examiner is respectfully requested to reconsider and withdraw the rejections in view of the amendments and remarks contained herein.

Information Disclosure Statement

At the outset, the Office Action indicates that the Examiner did not have an opportunity to review the non-patent literature submitted with the Information Disclosure Statement filed on June 9, 2006, prior to issuing the present Office Action on August 18, 2006. Applicants are submitting herewith a courtesy copy of the Information Disclosure Statement, Statement Accompanying the IDS, 1449 form, and the accompanying non-patent literature references submitted on June 9, 2006 (excluding non-patent literature previously submitted in the parent application).

37 CFR §1.132 Declaration

A 37 CFR §1.132 Declaration of Dr. Thomas R. Bieler, a co-inventor of the claimed invention, is being submitted herewith to provide factual evidence to address the §103 rejections and to clarify the claimed invention. In particular, Dr. Bieler's Declaration addresses U.S. Pat. No. 5,527,628 to Anderson et al. (hereinafter "*Anderson*") asserted in the 35 USC §103 rejections. For example, Dr. Bieler's Declaration explains that *Anderson* describes an incorrect

Sn-Ag-Cu eutectic composition due to calculation errors. The Examiner's consideration of this declaration is respectfully requested.

Applicants' Claimed Invention is Non-Obvious

The Examiner rejected Claims 20-24, 27-33, 36, 37, 39-45, 47-53, 55-59, and 62 under 35 U.S.C. § 103(a) as being unpatentable over *Anderson* et al. Claims 25, 26, 38, 46, and 61 also stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Anderson* in view of Lucey, Jr. et al. (U.S. Pat. No. 5,520,752) (hereinafter "*Lucey*"). Further, Claims 34, 35, 54, and 60 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over *Anderson* in view of Gibson et al. (PTO-1449) (hereinafter "*Gibson*"). These rejections are respectfully traversed.

Independent Claims 20, 39, and 54 have been amended to clarify the claimed invention. Independent Claims 20, 39, and 54 now commonly recite an intermetallic component present in a composite solder at greater than or equal to about 10 volume %. The intermetallic component is selected to have a density within about 10% of the density of the eutectic or near-eutectic matrix solder.

The *Anderson* Reference Does Not Constitute Properly Enabling Prior Art

The *Anderson* patent suffers from various fundamental legal defects that prevent its use as prior art, including a lack of written description (as the inventors do not appear to have been in possession of their invention or to have properly described it), lack of enablement to make and use the invention, and finally, for inoperability for its intended and claimed use.

All of the compositional ranges set forth in the *Anderson* patent are incorrect due to a conversion error that resulted in incorrect compositional ranges set forth in the detailed description. *See* Moon, et al., "Experimental and Thermodynamic Assessment of Sn-Ag-Cu

Solder Alloys," Journal of Electronic Materials, vol. 29, no.10, pp. 1122-1136 (2000), hereinafter the "*Moon*" reference;[1] Declaration of Dr. Bieler. The *Anderson* patent erroneously states that the eutectic composition for a Sn-Ag-Cu system is 93.6 Sn - 4.7 Ag – 1.7 Cu wt. %. *See e.g.,* Declaration of Dr. Bieler. Various third parties have recognized that the eutectic compositions set forth in the *Anderson* patent are erroneous and should in fact have been lower concentrations of silver and copper. *See e.g., Moon* at 1122. In fact, due to the calculation errors, the claims of the *Anderson* patent do not cover the actual eutectic or near-eutectic Sn-Ag-Cu solder compositions.

In Anderson, et al., "Microstructural Modifications and Properties of Sn-Ag-Cu Solder Joints Induced By Alloying," J. of Elec. Materials, Vol. 31, No. 11 (2002), some of the co-inventors of the *Anderson* '628 patent acknowledge the findings of the *Moon* article and further acknowledge the correct eutectic composition and temperature of 95.4 Sn – 3.7 Ag- 0.9 Cu wt.% at 217°C . *See, e.g.*, pp. 1166, 1167 and f.n. 6. This is the eutectic temperature that is currently recognized by those of skill in the art. *Id; see also, Moon* at 1122; and Declaration of Dr. Bieler. As such, one of skill in the art could not look to the *Anderson* patent for teaching Sn-Ag-Cu eutectic solders due to the extensive compositional errors set forth therein.

Here, the entire disclosure of *Anderson* is based upon calculation errors that provide inaccurate compositional ranges. The compositional ranges are far in excess of the actual eutectic or near-eutectic composition ranges, as later acknowledged by the inventors. Further, in proposing entirely erroneous compositional ranges, with no overlap with the true compositions for Cu, for example, the inventors of the *Anderson* patent were not in possession of any

[1] The *Moon* reference states that "[p]reliminary thermodynamic calculations performed by one of the authors [ ] and reported by Miller et al. predicted a ternary eutectic...[however] an error was made in the conversion from atomic to weight % conversion by Miller et al." *Moon* at p. 1122 Col. 2 bridging p. 1123 Col. 1. (*Footnotes omitted*). The *Moon* reference goes on to state that the eutectic composition of the *Anderson* patent should have been 96.06 Sn – 3.25 Ag- 0.69 Cu wt.% at 217°C.

embodiment of their invention. The *Anderson* reference is incorrect, inoperable, does not enable one of skill in the art to make and use the invention it claims, and further suffers from a lack of written description. In this regard, the *Anderson* patent does not constitute prior art to the presently claimed invention and should be entirely removed from consideration.

Even if *Anderson* is Considered, It Does Not Render Obvious Applicants' Invention

If the *Anderson* reference was modified to arrive at the claimed invention, it would be rendered inoperable for its stated purpose. The primary objective of *Anderson* is to arrive at a eutectic and/or near-eutectic solder that has a low melting point, specifically, less than 217°C + 15° (*i.e.*, 232°C). Col. 4 lines 55-65; Col. 5 lines 5-12. Hence, adding a significant concentration of one or more elements to form an intermetallic component at greater than 10 vol. % would impermissibly increase the melting temperature and/or "liquid-solid mushy zone" to far greater than 232°C. For example, a Sn-Cu alloy having 10 vol.% of a Sn_6Cu_5 intermetallic component has a melting point of greater than about 375°C. *See e.g.*, Attachment A.[2] Hence, modifying the compositions of *Anderson* to include intermetallic components at 10 vol.% or more would be entirely improper, as *Anderson* would contravene its stated objectives.

In fact, not only would *Anderson* be inoperable for its stated purpose, but *Anderson* explicitly teaches away from arriving at the claimed invention. For example, *Anderson* specifies that the solder should be less than 232°C and further states that a 260°C melting temperature is "far too great for electronic soldering." Col. 2 lines 5-8. The claimed composite solders having intermetallic components at greater than about 10 vol. % have melting temperatures well outside the range of acceptable melting temperatures specified by *Anderson*. An exemplary eutectic or

[2] Smithells Metals Reference Book, 7th edition, Butterworth Heinemann, Oxford, 11-242 (1992), submitted in the Office Action Response dated April 28, 2003 submitted in parent application U.S.S.N. 09/114,665 and attached here as Attachment A.

near-eutectic Sn-Ag-Cu solder having 10 vol. % percent of a Cu_6Sn_5 intermetallic has a total copper concentration of over 4.4 wt. %, and a melting temperature in excess of 310°C.[3] *Anderson* specifies that copper should only be present at up to 4.0 wt. %. Col. 5 lines 22-24. This is notwithstanding the fact that *Anderson* sets forth incorrect weight percentages and that the true eutectic or near-eutectic solder compositions should be significantly lower. Such an amount of an intermetallic component present in a composite solder far exceeds the minor concentrations taught by *Anderson.* Thus, the claimed invention is entirely non-obvious in light of the teachings of *Anderson.*

None of the cited references disclose, suggest, or provide the necessary motivation to begin with a eutectic or near-eutectic solder matrix and add intermetallic components at relatively high concentrations (greater than 10 vol. %) while ensuring a small particle size (less than about 10 μm) and a density that is close to that of the solder matrix (within about 10 %). The density and particle size of the intermetallic components ensure that relatively high concentrations of intermetallic components remain homogeneously distributed, even when exposed to heat (*e.g*, through reflow and service use), thereby providing the requisite strengthening for a solder joint. *See* for example, Applicants' specification at Page 8 line 1 to Page 9 line 11. *Gibson* lacks any disclosure or suggestion of the processes of Applicants' claimed invention, namely of adding an intermetallic at greater than about 10 vol. % to a eutectic or non-eutectic solder matrix in the manner claimed. Similarly, *Lucey* makes no disclosure of the methods of the present invention, and does not suggest adding the components of an

[3] A Cu concentration in excess of only 2.6 wt. % (where Ag is about 0.2 wt. %) provides a liquidus melting temperature of 310°C per the ternary phase diagram in Moon et al., "Experimental and Thermodynamic Assessment of Sn-Ag-Cu Solder Alloys", J. of Elec. Materials, Vol. 29, No. 10, Pp. 1122-1136 (2002) – Figure 14(a) at Pp. 1131, which is also reproduced in Attachment B.

intermetallic to an already formed solder matrix. Hence, neither *Gibson* nor *Lucey* do anything to remedy the deficiencies of the *Anderson* reference.

Moreover, none of the cited art, including *Anderson,* describes heating the mixture of components to a temperature greater than the highest melting temperature of all of the individual components of the mixture to melt and form a non-solid mixture during the formation of the composite alloy, such as set forth in Claim 54. *Anderson* merely describes heating the solder to a melt pour temperature of about 300°C. Col. 6 line 32. This is insufficient to fully melt the elements of a Sn, Ag, Cu system, where the melting temperatures of Sn, Ag and Cu are about 232°C, about 962°C, and about 1085°C, respectively. Claim 54 requires heating to at least 1085°C for the comparative Sn-Ag-Cu system, which is not described or suggested by *Anderson.*

Claim 54 further provides distinct steps of heating the composite solder to a temperature greater than a melting point of the matrix solder, but to a temperature less than the melting point of the intermetallic component, thereby melting only the matrix solder. Then the composite solder is cooled and solidified to form a solder joint where the composite solder has a greater solder joint strength, as well as greater creep and fatigue resistance, than a comparative solder joint formed from a eutectic or near-eutectic solder alone. The intermetallic components of the claimed invention remain evenly distributed and provide strengthening of the solder joint and greater fatigue resistance than a conventional eutectic solder that lacks the homogeneously distributed intermetallic components at 10 vol. % or greater, where the intermetallic has a particle diameter of less than about 10 μm. Thus, none of the cited references teach, or provide the necessary suggestion or motivation for a process where the solder is melted, cooled, and re-melted, as in Claim 54.

Applicants respectfully submit that Claims 26 to 62 are non-obvious in view of *Anderson,* either standing alone, or in combination with either *Gibson* or *Lucey.* Accordingly, Applicants request reconsideration and allowance of the pending claims.

A prior art reference must be enabling under 35 USC §112, First Paragraph, for a skilled artisan to not only comprehend the invention, but also to make it, and further must sufficiently describe the claimed invention to place the public in possession of it. *See Paperless Accounting Inc. v. Bay Area Rapid Transit Sys.*, 231 USPQ 649, 653 (Fed. Cir. 1986); *Reading & Bates Construction Co. v. Baker Energy Resources Corp.*, 223 USPQ 1168, 1173 (Fed. Cir. 1984). *and In re LeGrice,* 133 USPQ 365, 369-73 (CCPA 1962). Additionally, the written description requirement requires a patent to adequately describe the technology sought to be patented to satisfy the inventor's obligation to disclose the technologic knowledge upon which the patent is based, and to demonstrate that the patentee was in possession of the invention that is claimed. *See Falkner v. Inglis*, 79 USPQ.2d 1001, 1007 (Fed. Cir. 2006).

CONCLUSION

Prompt and favorable consideration of this amendment is respectfully requested. If the Examiner believes that personal communication will expedite prosecution of this application, the Examiner is invited to telephone the undersigned at (248) 641-1600.

Respectfully submitted,

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